

**PROSPECTUS
FOR
SEOUL CITY GAS PLANT**

October, 1971

**The Government of the Republic of Korea
Seoul, Korea**

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Summary of the Project

1. Project Title : Seoul City Gas Project
2. Project Sponsor : Metropolitan Government of Seoul
3. Estimated Required Fund :
Foreign capital : \$ 15,621,179
Local Capital : ₩ 6,639,878,000
4. Project description : Establish and operate city gas plant for the domestic, commercial and industrial gas demand in Seoul City. The initial 8 years project will produce 300,000m³ of gas with 7,000 Kcal/m³ of calorific value, the breakdown of which is 258,000m³ for domestic consumption and 42,000m³ for commercial and industrial uses.
5. Project Benefit : Through conversion of anthracite briquette to naphtha city gas, the efficiency of fuel utilization in Seoul will increase from 38.5% contributing considerably to the national fuel saving. Since 56.2% of Korean fuel is now imported, fuel saving is now directly related to foreign exchange saving, favorable trade balance and self-sufficiency in Korean economy as a whole. On the other hand, the citizens of Seoul City will enjoy the convenience of modern fuel at less cost, less labor in fuel handling, cleaner home and town as a whole, less gas poisoning, and saving in city budget by eliminating ash disposal expenditures.

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Section I. Nature of the Project

A. Introduction & Background

- a. The purpose of this project is to manufacture city gas in Seoul for domestic, commercial and industrial uses in order to replace the present anthracite briquette as far as possible.
- b. The modernization of fuel system is necessary to increase overall efficiency of fuel efficiency, for saving in coal handling labor, ash disposal city budget and national transportation load; for cleaner homes and city as a whole; and for less gas poisoning and air pollution.
- c. Through adoption of a modern gas fuel system, housewives can save considerable time formerly required to replace the briquette and remove its ash, and to clean the house and wash the clothing, now required more frequently due to the use of anthracite briquette. Although anthracite is cheaper by calorific value, gas could be used at higher fuel efficiency, thus the consequent gas cooking bills are less.
- d. The supply of city gas can encourage high accuracy industries using high convenience fuel, such as brown tubes for television, transistors and aluminum tapes for electronic industries, enameled decorations and art wares, christmas bulbs, etc. City gas will also be suitable for small scale domestic industries requiring less capital but considerable employment of skilled labor.

B. Project description

a. The proposed Seoul city gas project will establish two gas plants with a total capacity of 300,000m³/day of 7,000 Kcal/m³ gas with locally available naphtha as feed stock, distribute the gas through gas holders, pipes and metering system to each consumer, billing and collecting the gas proceeds under an integrated management.

Since a city gas project is a public utility enterprise, the establishment and management of this gas enterprise will be supervised, protected and controlled by the Government by the Gas Law to be promulgated in the near future.

With a reasonable gas billing rate, the consumers can profit from cheaper fuel cost while the proposed project will be able to pay back the loan with sufficient profit under adament financial stability. For such purpose, the project sponsor has to use low interest loan with sufficient repayment period, in accordance with general practices of city gas industry in other countries. In order to reduce the interest payment, a low interest foreign loan is necessary, as the proposed gas project is government endorsed after sufficient feasibility studies.

b. Forecast of Gas Demand

Unit: Household

Supply plan by Year

<u>By year</u>	<u>Southern Area</u>	<u>Eastern Area</u>	<u>Total</u>
1971	5,000		5,000
'72	20,000		20,000
'73	25,000		25,000
'74	25,000	15,000	40,000
'75	25,000	25,000	50,000
'76	20,000	30,000	50,000
'77	15,000	40,000	55,000
'78	15,000	40,000	55,000
Total	150,000	150,000	300,000

Southern construction project for 150,000 households and eastern construction project for 150,000 households were made on the basis of supply plan shown in the foregoing paragraph.

c. Present status of project

A gas plant producing $5,000\text{m}^3$ of 7,000 Kcal/ m^3 of butane is in operation under Seoul city management, the distribution system of which will be used to supply naphtha gas when it will become available in 1972.

d. Fund

The estimated foreign currency requirement for this project is \$15,621,179 for the procurement of gas plant, instruments and equipment not produced in Korea; and the estimated local Fund requirement is W6,639,878,000 for purchase of site, construction of buildings, installation of gas pipings, machineries and equipment produced in Korea.

Under current exchange rate, the won value of dollar is approximately 375 W.

e. Engineering service

The designing, fabrication, installation, start up operation and operator training program will be serviced by Foreign Engineering Groups, while piping will be installed under the responsibility of the local contractors. No engineering difficulties are expected because parties concerned are well experienced in the field in which they are to partake.

Preliminary and detailed feasibility studies have been made to decide the gas demand and marketability, suitability of raw material, gas - making process and product gas quality as well as distribution system layout.

f. Procurement of loan financed

Procurement by new loan in 1972 will be made in close coordination with financer's concurrence.

The loan requirement details are available in the master plan but the procurement cost will be decided annually in accordance with current market quotations and price index.

g. Construction.

Plant construction will be executed by the project sponsor under the supervision and guidance of the plant maker.

All laborers, workmen, technicians, skilled or unskilled, are available in Seoul where considerable similar work is being carried out.

h. Operation and maintenance

Plant operators will be trained during and after the plant construction, both in the field of basic engineering knowledge and actual operation on-the-job know-how. Maintenance men will be trained in the same way so that both operators and maintenance men will become capable of running the plant when the initial and start up operation is completed under the supervision and guidance of plant manager.

i. Soundness of Project

This project is sound and feasible because

- (1) Demand of gas fuel is fast increasing along with total increment of fuel demand with increasing population and fast expanding industries.
- (2) High efficiency utilization of economic and convenient modern fuel is necessary to cope with the economic development of the country.
- (3) Modernization of fuel system is necessary along with modernization of the country as a whole.
- (4) City gas industry is now a common practice in Japan, U.S. and other countries and can well replace existing system of anthracite briquette in its cost and convenience.

The project sponsor believes that this project is sound in all respects both economically and technically, thus no difficulty will result in paying back the loan in scheduled time.

SECTION II. APPLICANT

A. General Features

Name : Metropolitan Government of Seoul,
Republic of Korea.

Present status : Population : 5,536,377 (End of 1970)

Number of household : 1,091,015

(End of 1970) 300,000 to get gas
supply.

Estimated per capita annual income
in 1970: \$402.40

Similar present operation: Water service, bus and
sewage system are under the manage-
ment of Seoul Metropolitan Government,
all of them in satisfactory financial
condition.

B. Description of Gas to be Manufactured

Raw material : Naphtha produced in Korea

Product gas : Calorific value: 7,000 Kcal/m³

Weaver's Flame Speed Index: 30.3

Specific gravity (Air as 1) : 0.67

Approximate Gas Analysis:

CO ₂	4%,	C ₂ H ₄	21%,
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C ₃ H ₆	3%,	O ₂	Trace,
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CO	6%,	H ₂	26%,
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CH ₄	24%,	N ₂	16%,
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C. Present Fuel Method

Although propane, kerosen and electricity are used
as minor heat source,

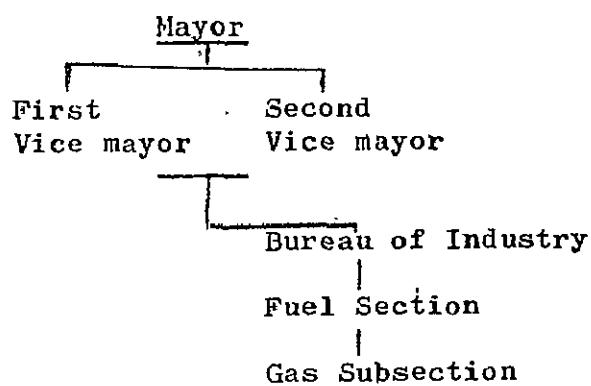
about 85% of 13,500,000 tons of annual anthracite production is consumed as household fuel in the form of holed briquette, beside which fire wood and agricultural by-products are used as country-side fuel in Seoul, anthracite briquette occupies 34.4% of the total fuel consumption, oils occupy 15.1% and propane 0.5%. Since Korean anthracite is difficult to ignite, anthracite briquette is kept burning at all times even during the hot summer days when only 9% of the heat generated is used for cooking. During winter time, the heat after cooking is used for warming Ondol, thus the heat efficiency is around 68% thus giving an annual average heat efficiency of 38.5%.

Since the naphtha gasification efficiency is around 90% in case of high efficiency N.R.G process and the efficiency of gas combustion is 90%, the overall naphtha gas heat efficiency is around 81%.

In addition to the fact that anthracite briquette has low heat efficiency, changing briquettes in the braziers, ash removal, briquette delivery, etc., involves huge labor, transportation load, dust from handling briquette ash which requires more house cleaning and clothes washing; and Co and So₂ gas evolved from briquetted combustion are severe menace to health by Co poisoning and air pollution to whole city.

D. Organization Chart

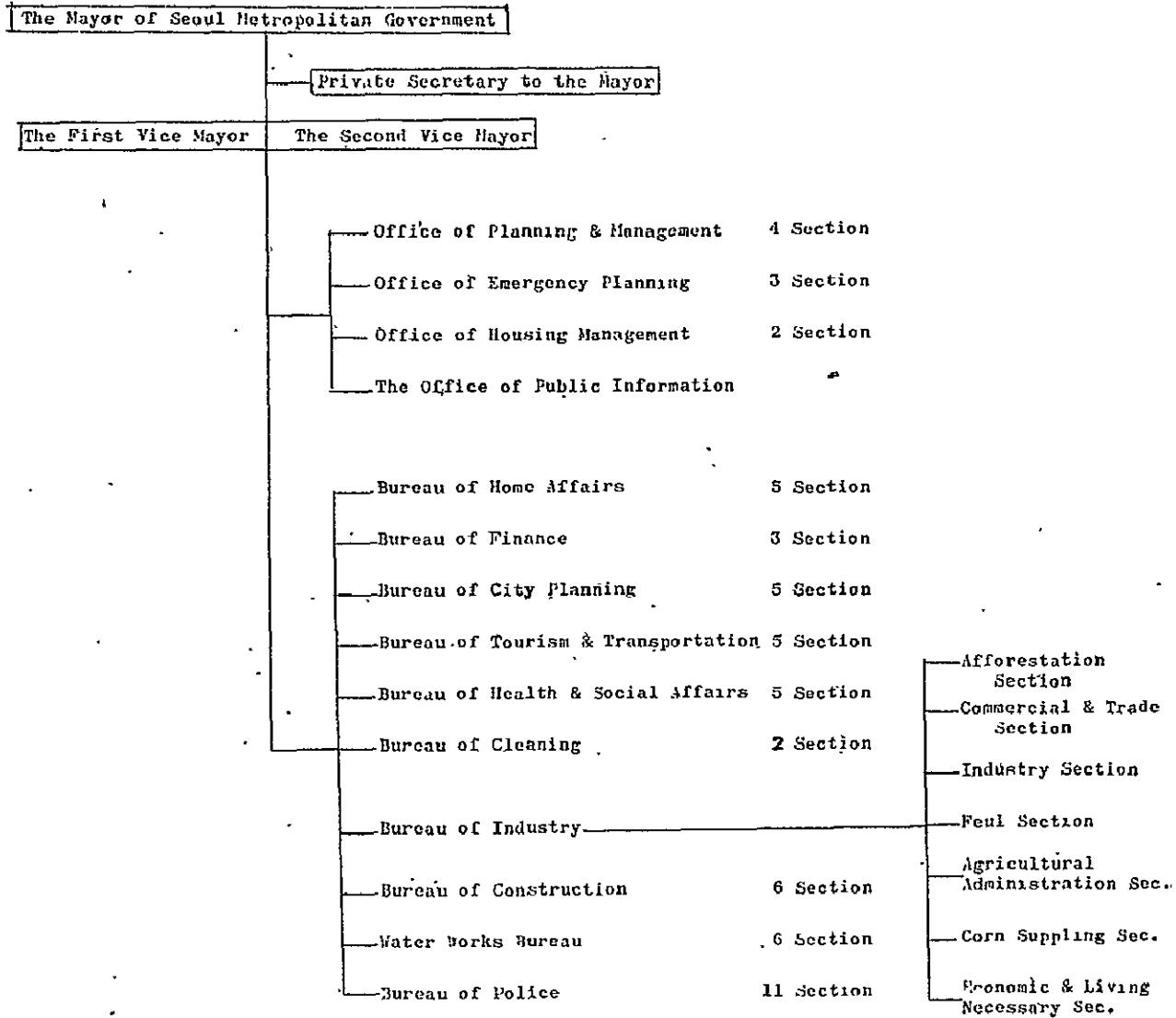
a) Existing



If the project should begin in earnest on the basis of this project design, Seoul city will have another separate organization of Bureau class for this project by 1975 at latest, and the business administration criteria to be applied to this project will be under the Municipal Utility Law, in Korea, made on the basis of Self-financial system.

ORGANIZATION CHART OF SEOUL METROPOLITAN GOVERNMENT

As of Aug. 1971



III. Technical Aspects

A. General Features

This project has the advantage of using cheap naphtha as the feed stock, the comparison of which being as follows:

Light oil	9.66	W/l
Kerosene	13.04	"
Heavy oil	7.15	"
Diesel oil	6.35	"
Bunker C oil	4.79	"
Light Diesel oil	8.09	"
Naphtha	4.70	"
Asphalt	7.30	"
Propane	35.10	W/kg
Butane	25.10	"

Although Korean naphtha has extremely high sulphur content (Korean 0.12% British 0.01 - 0.02% Japanese 0.026%), through selection of suitable gasification process (NRG process) high sulphur raw naphtha will be used as feedstock without desulfurization step, to desulfurize the product gas to acceptable standard of 0.5 gram/m³ of product gas.

NRG process can produce high calory gas without catalyst or methanization step, thus saving considerably in gas holder and piping size.

The NRG gas generator could be operated continuously unlike cyclic gas generator, with wide range of raw materials by a little adjustment in the equipment prior and subsequent to the reactor with no change in reactor itself.

The calorific value of the product gas can be adjusted freely with adjustment in operation conditions.

The gas transmission is planned to be executed under high pressure in the long distance main pipes, under a pressure of around 9Kg/Cm², while service pipes to consumers will maintain a pressure of around 170mm. W.G. requiring no individual pressure regulator at consumer end.

B. Engineering Data.

The process of gas making and gas distribution is similar to those widely used in Japan with many years of operation history, thus sufficient engineering data is available for this project, although utilization of local materials, equipment and machinery requires close check up by expert tests, analysis and inspection to see whether they are fit for the original specifications.

C. Site selection.

Two sites will be selected because one 150,000m³/day plant will be built in Yungdeungpo area while another plant will be built in Tongdaemoon area,

The plant site in Yungdeungpo area has already been decided along the highway to Kimpo air field with a space of 5.185 pyong (17,140 square meter).

Transport of naphtha to this site will be convenient from Inchon or from railroad station in Yongsan or Seoul. The pipings of the two plants will eventually meet together at the center of Seoul City because construction of gas plant at the center of Seoul City is not feasible economically and, from safety point of view.

D. Plan of operation

Seoul City will establish and operate two gas plants under its own responsibility as no civilian enterpriser can do the same under the present circumstances.

However, when this project can establish itself as stable business, may be in ten years of so, as foreseen by financial forecast, this project will be sold to civilian enterprisers as has been done in the case of Tokyo Gas or Osaka Gas Company.

Incidentally Tokyo Gas has the third largest proceeds in Japanese business.

E. Demand

The city gas under this project will be sold mainly for cooking purpose at the start but consumption for space heating will gradually increase with the increase in European type houses and improvement in heating system of Korean type houses.

The demand for cooking is estimated at $0.86\text{m}^3 - 1\text{m}^3/\text{day}$ of $7,000 \text{ Kcal/m}^3$ gas.

The consumption tendency of butane and propane air gas at I-chondong indicates that steady and positive increase in demand will develop for city gas under the prevailing economic circumstances.

F. Overall Technical Soundness

The fast increasing demand of propane gas in Seoul indicates that modernized and convenient gas fuel is gradually in great demand certifying to the economic feasibility of city gas in Seoul.

City gas was in operation from 1909 to 1949 in Seoul. Its rehabilitation was difficult due to the emergence of anthracite as cheap domestic fuel. Thus there is no technical difficulty in this project when low interest funds are available in sufficient amount.

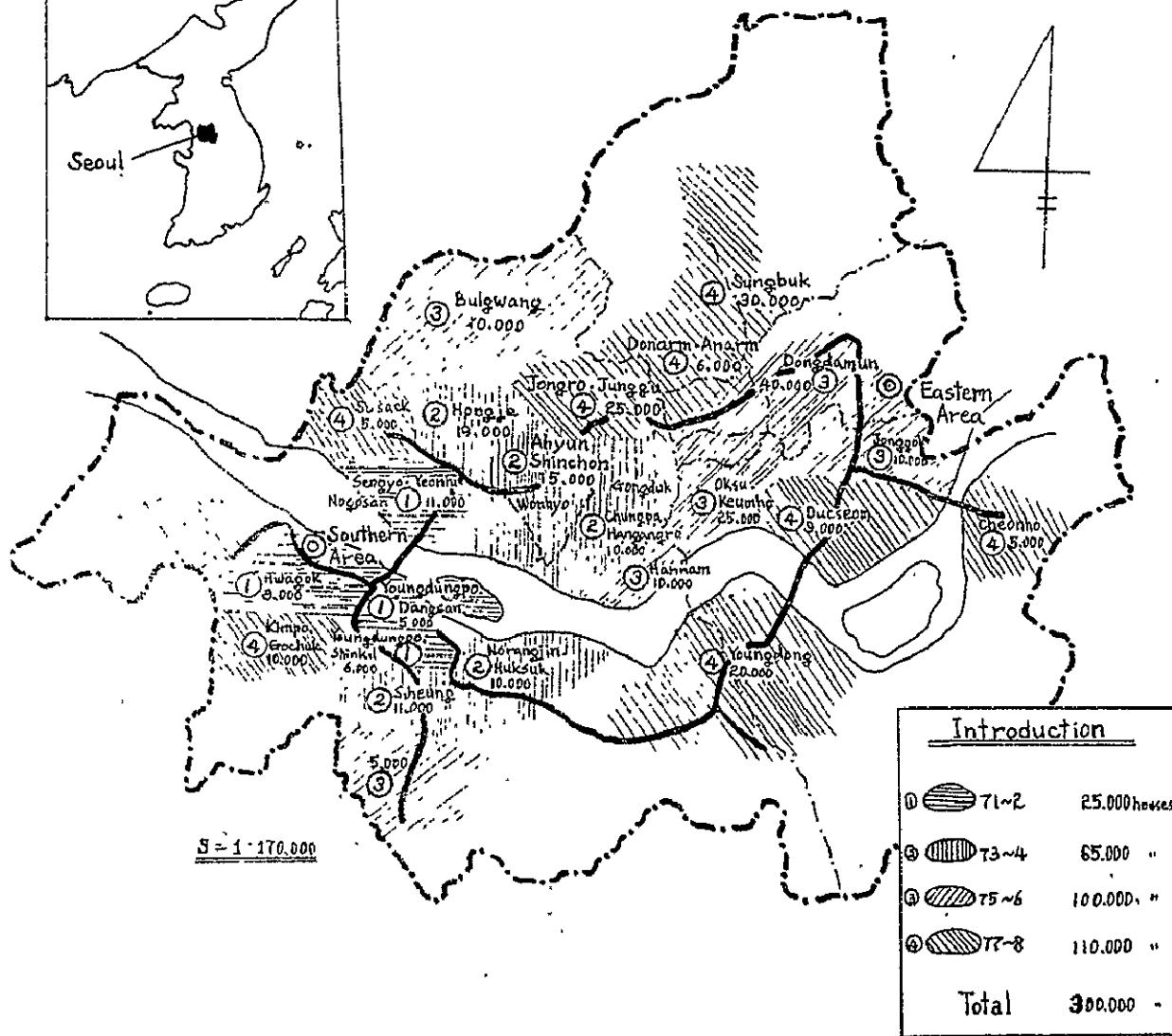
The anthracite coal is no more attractively cheap, due to the increase in ash content from 15% to 30%. The calorific value decreased from 6,000 Kcal/Kg average in 1952 to 4,700 Kcal/Kg in 1970.

Project plan by Years

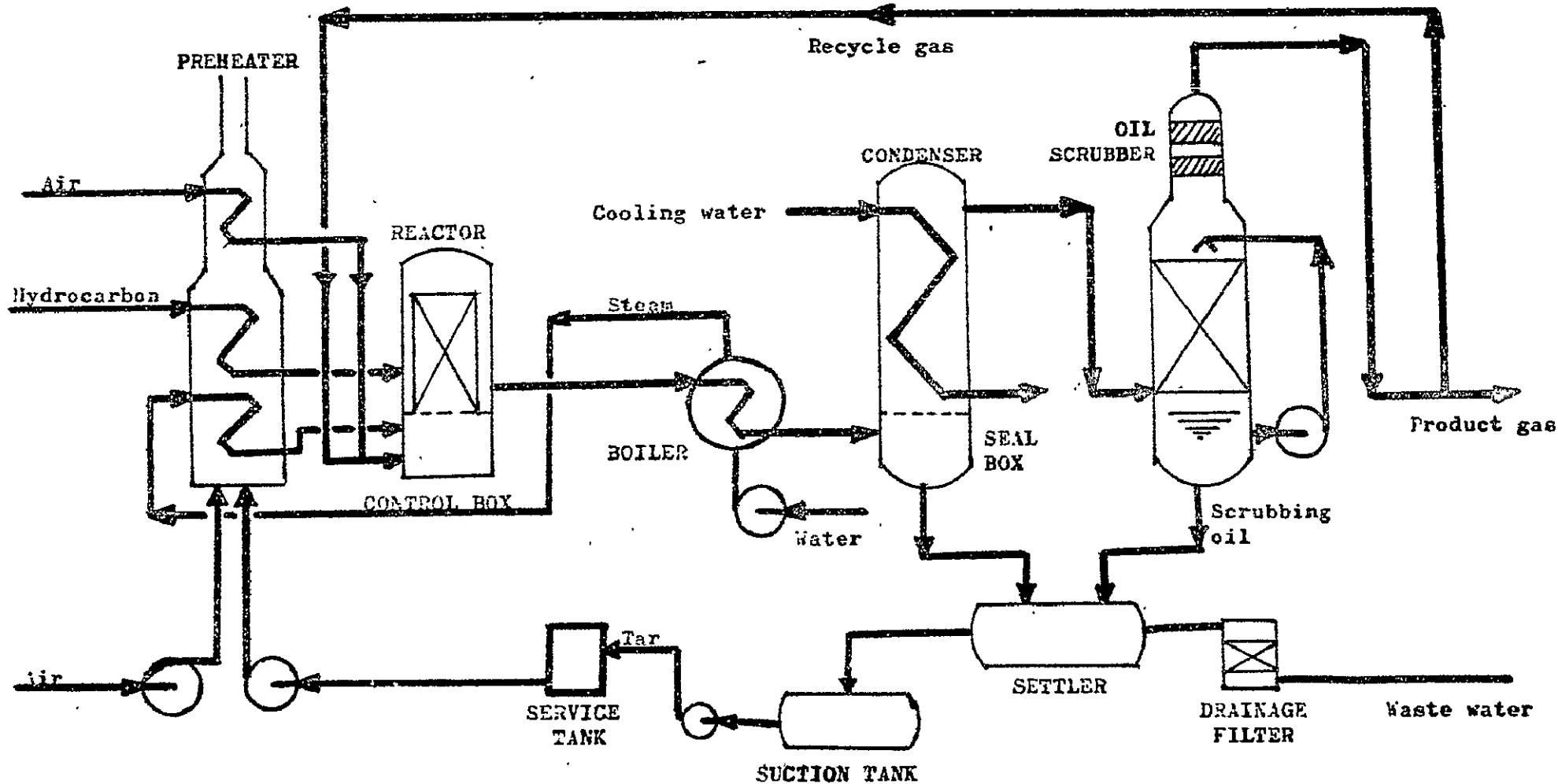
<u>Process</u>	<u>Year</u>	71	72	73	74	75	76	77	78	Total
	South Plant	50,000			50,000		50,000			150,000
Manufactory	East Plant				50,000		50,000		50,000	150,000
(M ³ /day)	Total	50,000			100,000		100,000		50,000	300,000
	South Plant	5,000			10,000					15,000
Gas Holder	East Plant				5,000		10,000			15,000
(M ³)	Total	5,000			15,000		10,000			30,000
	South Plant	5,000	20,000	25,000	25,000	25,000	20,000	15,000	15,000	150,000
Distribu- tion system	East Plant				15,000	25,000	30,000	40,000	40,000	150,000
(house)	Total	5,000	20,000	25,000	40,000	50,000	50,000	55,000	55,000	300,000



Supply Plan for Town Gas



PROCESS FLOW CHART



Section IV. Economic & Financial Aspects

A. Estimated Capital Cost

1. Land and Right

a. Southern project	W 120,000,000
b. Eastern project	W 120,000,000
Total	W 240,000,000

2. Engineering Costs

a. Preliminary engineering up to time of application	W 18,000,000 or \$ 48,450
b. Design, preparation of contract documents, supervision	W103,000,000 or \$346,700

3. Construction Costs

Schedule is as follows:

Summary of Estimated Construction Cost

<u>Item and Description</u>	<u>Fund Requirement</u>		<u>Total Expressed in</u>	
	<u>Local Currency</u>	<u>U.S. Dollar</u>	<u>Local Currency</u>	<u>U.S. Dollar</u>
1. Land and Land right	W 240,000,000		240,000,000	640,000
2. Construction Cost	5,732,026,000	\$15,046,262	11,374,374,000	30,331,664
3. Engineering Cost (Design)	60,000,000		60,000,000	160,000
4. Engineering Cost (Supervision)	43,000,000		43,000,000	114,667
5. Contingency	564,852,000	574,917	780,446,000	2,081,189
Total	W 6,639,878,000	\$15,621,179	12,479,820,000	33,327,520
Portion to be financed by applicant	6,639,878,000		6,639,878,000	17,706,341
Remaining cost to be covered by loan		\$15,621,179	5,857,942,000	15,621,179
Total of Fund Source	6,639,878,000	15,621,179	12,479,820,000	33,327,520
Percentage	Local cost; 53.12%	Dollar cost; 46.88%		

Investment Plan of Local & Foreign Fund

Southern Project

By Year

Division

	'71	'72	'73	'74	'75	'76	'77	'78	Total
Manufactory	500,009	30,000		653,335		263,335			1,446,679
Distribution System	212,362	362,855	653,557	575,538	606,068	534,686	411,512	408,006	3,064,386
Gas-Meter	50,000	120,000	150,000	150,000	150,000	120,000	90,000	90,000	900,000
Local Fund	411,111	435,177	472,948	567,571	441,256	442,109	297,050	295,256	3,362,478
Total	551,260	277,678	330,609	811,302	314,812	473,914	204,262	202,750	2,946,587
Foreign Fund							501,312	498,006	6,311,063
Total	742,371	712,855	803,557	1,378,875	756,068	918,023			

Eastern Project

Manufactory

Distribution System

Gas-Meter

 Local Fund

Total

 Foreign Fund

 Total

		550,009		653,335		263,335	1,446,679
		382,794		611,552	736,954	1,042,856	1,065,923
							3,840,479
		90,000		150,000	180,000	240,000	240,000
		669,935		444,654	682,681	754,367	825,763
							3,277,400
		432,868		316,898	887,608	528,489	743,495
							2,909,558
		1,002,803		761,552	1,570,289	1,282,856	1,569,258
							6,186,758
		411,111	435,177	472,948	1,137,506	883,910	1,124,790
Grand-total	551,260	277,678	330,609	1,244,170	651,710	1,363,522	732,751
							946,245
							5,857,945
		742,371	712,855	803,557	2,381,676	1,517,620	2,488,312
							1,784,168
							2,067,264
							12,197,823

Note : Total contingency costs in the amount of W780,446,000

are distributed to each above item such as Manufactory, Distribution system, Gas-Meter etc.

B. Working Capital Requirements

Southern Project	W 150,000,000	or	\$ 400,000
Eastern Project	W 150,000,000	or	\$ 400,000
	W 300,000,000		\$ 800,000

C. Running Cost

	<u>Southern project</u>	<u>Eastern project</u>	<u>Total</u>
<u>For the period of Construction</u>			
Capacity cost	W 3,479,696,000	W 1,781,109,000	5,260,805,000
Commodity cost	W 1,190,325,000	W 567,016,000	1,757,341,000
Total	W 4,670,021,000	W 2,348,125,000	7,018,146,000

Annual Running Cost

After completion
of Construction

Capacity cost	W 934,674,000	W 914,644,000	1,849,318
Commodity cost	W 338,109,000	W 338,109,000	676,218
	W 1,272,783,000	W 1,252,753,000	2,525,536

D. Gas rate

1. Proposed Gas Rate	₹ 35/M ³ (7,000 Kcal)
2. Current Gas Rate	₹ 35/M ³ (7,000 Kcal)
3. Gross income estimated for the first 10 years after completion of Project.	
Total income from sales of gas:	₹ 31,283,000,000
Total expense for the period :	<u>₹ 24,341,316,000</u>
Balance (net income)	₹ 6,941,674,000

E. Profitability

Analysis of predicted profit & loss, forecast of
earnings and receipts and expenditures.

Unit : 1,000 won

I. Earnings from operations

Revenue

	Construction period from '71 to '78	From '79 to '88 after construction
1. Annual sales (1,000M ³)	231,623	893,800
2. Unit gas rates per M ³	35	35
3. Gross revenue from sales (1x2)	8,106,837	31,283,000

Running cost, Net income & Profit

4. Operating & Maintenance expenses	1,483,145	4,956,000
5. Depreciation allowance	2,586,308	9,265,410
6. Commodity cost	1,757,341	6,762,180
7. Total running cost (4+5+6) before on long-term debt	5,826,794	20,983,590
8. Net income before interest on long-term debt (3-7)	2,280,043	10,299,410
9. Interest on long-term debt	1,191,437	3,357,721
10. Net profit (8-9)	1,088,606	6,941,689

II. Source of Funds

11. Net income before interest	(8)	2,280,043	10,299,410
12. Depreciation allowance	(5)	2,586,308	9,265,410
13. Aid in construction from general customers		1,800,000	
14. Receipts from sales of Gas Meter		1,800,000	
15. Fund from Seoul City government		988,957	
16. Total receipts of the funds, free interest	(11--15)	9,455,308	19,564,820
17. Foreign Loan		5,824,957	
18. Total sources of funds	(16+17)	15,280,265	19,564,820

Unit : 1,000 won

III. Use of Funds

		<u>Construction period from '71 to '78</u>	<u>From '79 to '88 after construction</u>
19. Construction expenditure			
a) Foreign currency in won	5,824,957	5,149,705	
b) Local currency	6,672,866		
Total construction expenditures	12,497,823		
20. Working capital	240,000	60,000	
21. Debt service	1,316,754	6,640,217	
a) Amortization of principal	125,317	3,282,496	
b) Interest on long-term debt	(8) 1,191,437	3,357,721	
22. Total expenditures	(19--21) 14,054,577		
23. Surplus of cash	(18 - 22) 1,225,688	7,714,898	
24. Total use of funds	(22-23) 15,280,265	19,564,820	

IV. Balance-Sheet, End of Period

<u>Assets</u>		<u>End of 1978</u>	<u>End of 1988</u>
25. Current assets		1,465,688	9,240,586
26. Capital assets		12,497,823	17,647,528
27. Gross assets		12,717,823	26,888,114
28. Accumulated depreciation	(5)	2,586,308	11,851,718
29. Net fixed assets	(26-28)	9,911,515	5,795,810
30. Total assets, end of period	(29+25)	11,377,203	15,036,396
<u>Liabilities</u>			
31. Foreign loan		5,699,640	2,417,144
32. Fund from Seoul city government		988,957	988,957
33. Surplus		4,688,606	11,630,295
a) Aid in construction		1,800,000	1,800,000
b) Receipts from sales of gas meter		1,800,000	1,800,000
c) Earned surplus		1,088,606	8,030,295
34. Total liabilities	(31--33)	11,377,203	15,036,396

F. Ability of project to meet cost

- for 10 year after completion of project. -

<u>Division</u>	<u>Southern project</u>	<u>Eastern project</u>	<u>Southern & Eastern project</u>
Revenue from sales of gas	\$15,641,500,000	\$15,641,500,000	\$31,283,000,000
Operating & maintenance	2,478,000,000	2,478,000,000	4,956,000,000
Depreciation	4,731,720,000	4,533,690,000	9,265,410,000
Interest	1,654,341,000	1,704,380,000	3,358,721,000
Commodity Cost	3,381,090,000	3,381,090,000	6,762,180,000
Refund to Principal	<u>1,617,614,000</u>	<u>1,664,881,000</u>	<u>3,282,495,000</u>
Total cost and refund to principal	<u>\$13,862,765,000</u>	<u>\$13,762,041,000</u>	<u>\$27,624,806,000</u>
Balance (+)	\$ 1,778,735,000	\$ 1,879,459,000	\$ 3,658,194,000

The Balance shows gas rate revenues sufficient enough to cover cost and refund to principal for 10 years after completion of construction.

G. Benefit - Cost Analysis

a) B/C ratio

Benefit-cost ratios were calculated using analysis period of 30 years at 12%, synthetic discount rates of 7.5 and 15 percent.

Seven and a half percent were applied as the world bank's current rates, and 15 percent were applied as the opportunity cost of capital in Korea.

Applied rates, 12% were calculated as follows:

$$\text{Local fund} : 6,639,878,000 \times \frac{15}{100} = 995,981,700$$

$$\text{Foreign fund} : 5,857,945,000 \times \frac{7.5}{100} = 439,345,875$$

$$100 \times \frac{995,981,700 + 439,345,875}{6,639,878,000 + 5,857,945,000} = 11.5 (\approx 12\%)$$

Southern project : 1,087

Eastern Project : 1,105

Eastern & Southern projects : 1.1 (discount rate 12%)

b) I.R.R.

Southern project : 12.5 - 13%

Eastern project : 12.5 - 13%

Southern and Eastern projects: 13%

The internal rate of return (I.R.R) for the product, 13% is higher than discount rate of 12%

H. Analysis of associated benefits

a) Saving in energy resources

1. Annual briquette demand for 300,000 household:

13,500,000 M/T

2. Combustion efficiency of briquette
(domestic use) : 38.5%

3. Combustion efficiency of town gas: 100%

$$1,350,000M/T \times 38.5 (\%) = 519,750M/T$$

$$1,350,000M/T - 5,197,500 = 830,250M/T$$

Annual saving in briquette from loss: 830,250M/T

b) Annual cleaning cost reduced:

1. Annual cleaning expense for 300,000

household: ₩194,400,000

$$₩0.60 \times 1,080 \times 300,000 = ₩194,400,000$$

₩0.60 : cleaning expense per briquette

1,080 : annual briquette demand per household.

2. Annual cleaning expenditures of Seoul

$$1,350,000M/T \times 0.36 + 4M/T \times ₩3,000 = 364,500,000$$

0.36 : Weight per briquette ash

₩3,000: Freight per truck

4M/T : Load capacity per truck.

c) Traffic Saving

Annual railway car required

$$1,350,000M/T + 40M/T = 33,750 \text{ Cars}$$

Annual truck required

$$1,350,000M/T + 4 M/T = 337,400 \text{ Trucks}$$

To accomplish this project separately without any subsidy from General Account, we made I. I. R. described in G item, IV section above without considering the associated benefit.